

REMARKS

This is in full and timely response the non-final Office Action mailed on April 29, 2004. Reexamination in light of the following remarks is respectfully requested.

Claims 1-25 are currently pending in this application, with claims 1 and 11 being independent. No new matter has been added.

Rejection under 35 U.S.C. §112

Claims 1-10 were rejected under 35 U.S.C. §112, second paragraph.

This rejection is traversed at least for the following reasons.

The Office Action contends that a substrate made of a Group III-V nitride compound including at least one element from Group IIIB elements and at least nitrogen (N) from Group VB elements lacks clarity.

In response to this contention, it is well known and understood in the relevant art that under certain periodic tables nitrogen may be properly classified as a Group VB element and that gallium may be properly classified as a Group IIIB element.

The Office Action contends that a curvature smaller than or equal to 0.03 cm^{-1} lacks clarity.

In response to this contention, “a patentee can be his own lexicographer provided the patentee's definition, to the extent it differs from the conventional definition, is clearly set forth in the specification.” *Beachcombers v. Wildewood Creative Prods., Inc.*, 31 USPQ2d 1653, 1656 (Fed. Cir. 1994).

“For claim construction purposes, the description may act as a sort of dictionary, which explains the invention and may define terms used in the claims.” *General Electric Co. v. Nintendo Co.*, 50 USPQ2d 1910, 1914 (Fed. Cir. 1999).

The claim language “is not construed in a lexicographic vacuum, but in the context of the specification and drawings.” *Toro Co. v. White Consolidated Industries Inc.*, 53 USPQ2d 1065, 1069 (Fed. Cir. 1999).

The curvature K is obtained by the numerical expression 1 shown, for example, on page 7, line 1 of the specification as originally filed. In Figures 6 and 7, the vertical axis represents the curvature K in cm^{-1} and the horizontal axis represents the thickness t_2 of the substrate 12 in μm (specification as originally filed at page 12, lines 16-18).

In this regard, please note that the term “the curvature K in cm^{-1} ” has a clear and specific meaning in the art. For example, page 12, lines 13-14 of the specification as originally filed refers to Hiramatsu et al. (Jpn. J. Appl. Phys., Vol. 32 (1993), pp. 1528-1533) to further demonstrate the usage for the term “the curvature K in cm^{-1} ” as understood by one of ordinary skill in the art. Hiramatsu et al. has been submitted by the Information Disclosure Statement of November 28, 2001. Figure 2(a) of Hiramatsu et al. depicts the curvature K and Figure 4 of Hiramatsu et al. refers to the curvature K. Also note that the curvature K is found within equation (2) of Hiramatsu et al.

Additionally, Olsen et al. (Journal of Applied Physics, Vol. 48, No. 6, June 1977, pp. 2543-2547) further demonstrates the usage for the term “the curvature K in cm^{-1} ” as understood by one of ordinary skill in the art. Olsen et al. has been also submitted by the Information Disclosure Statement of November 28, 2001. Figure 2(a) of Olsen et al. depicts the radius of curvature R. Also note that the radius of curvature R is found within equation (2) of Olsen et al.

Please compare equation (2) of Hiramatsu et al. with equation (2) of Olsen et al.

Withdrawal of this rejection and allowance of the claims is respectfully requested.

Rejection under 35 U.S.C. §102 and §103

Claims 1-10 were rejected under 35 U.S.C. §103 as allegedly being obvious over U.S. Patent No. 6,252,261 to Usui et al. (Usui).

This rejection is traversed at least for the following reasons.

Claim 1 and the claims dependent thereon

Claim 1 and the claims dependent thereon are drawn to method of forming a substrate made of a Group III-V nitride compound including at least one element from Group IIIB elements and at least nitrogen (N) from Group VB elements, wherein the substrate is grown on a growth base with a thickness of smaller than or equal to 100 μm , the substrate having a thickness of larger than or equal to 200 μm and a curvature smaller than or equal to 0.03 cm^{-1} , the curvature being caused by a difference in thermal expansion coefficients of the growth base and the substrate.

Usui arguably teaches a GaN crystal film, a group III element nitride semiconductor wafer and a manufacturing process therefore that arguably includes a sapphire growth base 1 and a Group III-V nitride substrate 2 (figure 1A, column 6, lines 16-17).

While Usui arguably teaches the Group III-V nitride substrate 2 having a thickness of greater than or equal to 200 μm in that a GaN substrate with a thickness of 500 μm is epitaxially grown on a sapphire growth base (column 24, lines 51-52), Usui fails to disclose, teach or suggest a Group III-V nitride substrate being grown on a growth base of a thickness of smaller than or equal to 100 μm . Instead, Usui teaches that the GaN substrate with a thickness of 500 μm is epitaxially grown on a sapphire growth base with a thickness of 200 μm (column 24, lines 51-53). As a result, the sapphire growth base does not have the claimed thickness of smaller than or equal to 100 μm .

In this regard, the Office Action admits that Usui lacks at best a clear disclosure that the growth base would have a thickness of smaller than or equal to 100 μm . Yet the Office Action contends that column 24, lines 42-58 of Usui suggests that the base *should have* a thickness of less

than half of the deposited substrate in order to prevent cracking in the substrate due to curvature, and that it would seem rather clear in Usui that the thickness of the base is limited by the thickness of the deposited substrate in order to limit cracking and curvature in the substrate at the expense (i.e., cracking) of the base. The Office Action then asserts that it would have been within the skill level of the art to make a growth base having a thickness of smaller than or equal to 100 μm since Usui discloses a thickness of the deposited substrate as 100-500 μm .

In response to this position set out within the Office Action, initially note that within claim 1 and the claims dependent thereon *the substrate is grown on a growth base* with a thickness of smaller than or equal to 100 μm . While Usui arguably teaches that a crystal may be epitaxially grown on a hetero-substrate with a thickness of less than half of that of an epitaxial layer to be formed (column 24, lines 48-51), Usui *expressly* provides an example where the GaN substrate with a thickness of 500 μm is epitaxially grown on a sapphire growth base with a thickness of 200 μm . Especially by this example, Usui fails to show a substrate made of a Group III-V nitride that is grown on a growth base with a thickness of smaller than or equal to 100 μm , as claimed.

Please bear in mind that the Office Action acknowledges that Usui is *silent* as to a Group III-V nitride substrate that is grown on a growth base with a thickness of smaller than or equal to 100 μm . Instead, Usui arguably describes a procedure for removing a hetero-substrate, showing a specific example where a sapphire substrate is removed by grinding from a wafer fabricated by growing a GaN crystal with a thickness of about 250 μm on the sapphire growth base (column 24, lines 8-12). In this procedure, grinding by sandblasting was continued until the thickness of the sapphire substrate became about 50 μm (column 24, lines 26-27). But this procedure fails to disclose, teach or suggest the GaN crystal being grown on the sapphire growth base, wherein the sapphire growth base has a thickness of smaller than or equal to 100 μm . Instead, Usui teaches that the surface in the side of GaN crystal (wafer front face) is protected by an argillaceous so-called compound, then the exposed sapphire surface (wafer rear face) is ground by sandblasting (column 24, lines 13-16).

In addition to the arguments provided hereinabove, “one way for a patent applicant to rebut a *prima facie* case of obviousness is to make a showing of ‘unexpected results,’ i.e., to show that the claimed invention exhibits some superior property or advantage that a person of ordinary skill in the relevant art would have found surprising or unexpected.” *In re Geisler*, 43 USPQ2d 1362, 1365 (Fed. Cir. 1997).

In this regard, “all evidence of nonobviousness must be considered when assessing patentability.” *Richardson-Vicks Inc. v. The Upjohn Co.*, 44 USPQ2d 1181, 1186 (Fed. Cir. 1997).

“Consistent with the rule that all evidence of nonobviousness must be considered when assessing patentability, the PTO must consider comparative data in the specification in determining whether the claimed invention provides unexpected results.” *In re Soni*, 34 USPQ2d 1684, 1687 (Fed. Cir. 1995). See also, *In re Wright*, 6 USPQ2d 1959, 1962 (Fed. Cir. 1988).

Figure 6 of the specification as originally filed shows the relation between the thickness t_2 of the GaN substrate 12 and the curvature K of the substrate 12 when values in Table 1 below were assigned to the parameters in the numerical expression 1 (refer to Jpn. J. Appl. Phys., Vol. 32(1993), pp. 1528-1533, submitted by the Information Disclosure Statement of November 28, 2001) and the thickness t_1 of the growth base 11 made of sapphire was varied (specification as originally filed at page 12, lines 11-16). Figure 7 of the specification as originally filed shows a part of Figure 6 enlarged. In Figures 6 and 7, the vertical axis represents the curvature K in cm^{-1} and the horizontal axis represents the thickness t_2 of the substrate 12 in μm (specification as originally filed at page 12, lines 16-18). In accordance with the calculation model shown in Figure 6, the GaN substrates 12 with various thicknesses were grown by means of the HVPD over the growth bases 11 made of sapphire with various thicknesses, and the curvature thereof was obtained (specification as originally filed at page 13, lines 1-4). The curvature of the substrates 12 was obtained by measuring their reflecting angles (specification as originally filed at page 13, lines 12-13). Thus, a comparison between a conventional process and a process using the claimed invention has been provided within the specification.

“When an applicant seeks to overcome a *prima facie* case of obviousness by showing improved performance in a range that is within or overlaps with a range disclosed in the prior art, the applicant must ‘show that the [claimed] range is critical, generally by showing that the claimed range achieves unexpected results relative to the prior art range.’” *In re Geisler*, 43 USPQ2d 1362, 1365 (Fed. Cir. 1997).

In this regard, from the experiments of the specification as originally filed it was confirmed that the relation between the thickness t_1 of the growth base 11, the thickness t_2 of the substrate 12 and the curvature K , which were obtained with the actual measurement, greatly conformed to the calculation model shown in Figure 6 (specification as originally filed at page 13, lines 14-17). As shown in Figure 7, the curvature, 0.03 cm^{-1} was the critical point for causing crack and, when the curvature K of the substrate 12 was smaller than or equal to 0.03 cm^{-1} , no crack occurred in the substrate 12 (specification as originally filed at page 13, lines 17-20).

By making the thickness of the growth base 11 smaller than or equal to $100 \mu\text{m}$ and the thickness of the substrate 12 larger than or equal to $200 \mu\text{m}$, stress caused by the warping is concentrated in the growth base 11, thus cracks occur exclusively in the growth base 11 (specification as originally filed at page 7, line 19 to page 8, line 3). Further, the thickness of substrate 12 relative to the growth base 11 is adjusted so that the curvature K of the substrate 12 is smaller than or equal to 0.03 cm^{-1} , thus the substrate 12 is free from cracks 12 (specification as originally filed at page 8, lines 3-6).

“An applicant relying on comparative tests to rebut a *prima facie* case of obviousness must compare his claimed invention to the closest prior art.” *In re De Blauwe*, 222 USPQ 191, 196 (Fed. Cir. 1984).

The Office Action cites Usui. But as shown hereinabove, the substrate being grown on a growth base with a thickness of smaller than or equal to $100 \mu\text{m}$, the substrate having a thickness of larger than or equal to $200 \mu\text{m}$ and a curvature smaller than or equal to 0.03 cm^{-1} , the curvature

being caused by a difference in thermal expansion coefficients of the growth base and the substrate, are absent from Usui. Thus, Usui fails to show the unexpectedly superior results, as claimed.

Claim 5 and the claims dependent thereon

Also note, claim 5 provides that the substrate is doped with impurities, and claim 6 provides that at least one selected from a group consisting of carbon (C), silicon (Si), germanium (Ge), tin (Sn), sulfur (S), selenium (Se) and tellurium (Te), or at least one selected from a group consisting of carbon, silicon, germanium, tin, beryllium (Be), magnesium (Mg), calcium (Ca), zinc (Zn) and cadmium (Cd) is doped as the impurities.

However, Usui fails to disclose, teach or suggest base film 2 as including impurities.

New non-final Office Action

Withdrawal of this rejection and allowance of the claims is respectfully requested. But if the allowance of claims 1-10 is not forthcoming at the very least and a new ground of rejection made, then a **new non-final Office Action** is respectfully requested.

Newly added claims

Newly added claim 11 and the claims dependent thereon include the steps of:

providing a growth base of a thickness smaller than or equal to 100 μm , said growth base being sapphire, silicon carbide, spinel, gallium arsenide or silicon; and

growing the substrate on said growth base to a thickness greater than or equal to 200 μm , said substrate being a Group III-V nitride compound,

wherein said step of growing the substrate is performed after said step of providing said growth base.

At least for the reasons provided hereinabove with respect to the rejection of claims 1-10, Usui fails to disclose, teach or suggest the steps of claim 11 and its dependent claims.

Allowance of the claims is respectfully requested.

Conclusion

For the foregoing reasons, all the claims now pending in the present application are allowable, and the present application is in condition for allowance. Accordingly, favorable reexamination and reconsideration of the application in light of the amendments and remarks is courteously solicited.

If the Examiner has any comments or suggestions that could place this application in even better form, the Examiner is requested to telephone Brian K. Dutton, Reg. No. 47,255, at 202-955-8753 or the undersigned attorney at the below-listed number.

If any fee is required or any overpayment made, the Commissioner is hereby authorized to charge the fee or credit the overpayment to Deposit Account # 18-0013.

Dated: July 15, 2004

Respectfully submitted,

By

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